

Serial No. 09/735,930

REMARKS

Claim 1 has been amended and new claims 9 to 11 have been added better to point out that which applicants regard as their invention. The claims before the Examiner thus are claims 1 to 11.

1. Claim 1 is amended further to call for a heat-resistant inorganic oxide and a noble metal loaded on the heat-resistant inorganic oxide. Support for the revision appears in Paragraph [0015] and in original claim 3.

New claim 9 specifies that the substance capable of reacting with the alkali metal is disposed in the carrier. Support for claim 9 appears in Paragraphs [0011] and [0012].

New claim 10 specifies that the substance capable of reacting with the alkali metal is disposed between the carrier and the catalyst layer. The claim is supported by Paragraphs [0020] and [0021].

New claim 11 calls for the substance capable of reacting with the alkali metal to be disposed in the heat-resistant inorganic material. The Examiner is directed to Paragraphs [0015] to [0020] for support of this subject matter.

2. Applicants thank the Examiner for the courteous interview granted their representative on May 13, 2003. The substance of applicants' remarks made at the interview appear in the comments below.

3. Claims 1-8 were rejected under 35 U.S.C. 103(a) as unpatentable over Lindner et al., hereinafter "Lindner", (U.S. Pat. 6,348,430 B1) taken together with Deeba et al., hereinafter "Deeba", (U.S. Pat. 6,375,910 B1). The rejection is traversed.

The present invention is directed to solving a problem caused by the adverse effect alkali metals have on a catalyst carrier in catalyst compositions when the catalyst operates at high temperatures. This problem is discussed on page 2, lines 2-10, of the specification thusly:

The carrier, however, is easily corroded and deteriorated by alkali metals or some alkaline earth metals being activated under high temperature conditions derived from automobile exhaust gas, especially, Li, Na, K and Ca. In particular, there is a serious problem that a cordierite carrier made of an oxide type ceramic material generates cracks, since the carrier easily reacts with the above-mentioned alkali and alkaline earth metals, etc.

Applicants solved this serious prior art problem by inventing a catalyst with a long duration period. The catalyst of this invention is formed by adding an "anchor" material

(called in the claims "a substance capable of reacting with the alkali metal, dominating over the reaction between the main components of the carrier and the alkali metal") that will react more with these alkali metals than will the catalyst carrier. See also specification Paragraphs [0005] and [0006]. Preferred "anchor" materials are recited in claim 2. There is no teaching in the cited art of adding such an "anchor" material to a catalyst composition for any reason, let alone to solve this durability problem.

Applicants conducted tests to compare the catalyst of the present invention with four similar catalysts that did not contain the "anchor" materials. The catalyst compositions and test data are shown in Tables 1 and 2. A summary of the results of the data appears following those tables and reads:

[0073] As shown in Table 1 and Table 2, each of the NOx adsorption catalysts 1 to 32 based on the present invention, as compared with the comparative NOx adsorption catalysts 33 to 36 containing no anchor substance, was little in crack generation in carrier and low in strength decrease.

Turning to Table 2 in the second page for the four Comparative Examples 33-36 without any anchor substance, one sees that the generation of cracks was "very much" for three of the

Comparative Examples while the crack generation was "much" for the remaining comparative example. The decrease in strength for the four Comparative Examples was 75%, 79%, 80% and 58%; those values should be compared to the much lower values shown in the working examples.

There is no teaching or suggestion in the art of achieving such improved results by using an anchor material for an alkali metal-containing catalyst as claimed.

Lindner proposes merely using oxygen-storing components to cope with periodic variations in a normalized air/fuel ratio by releasing or binding oxygen. See Lindner at col. 1, lines 28 to 41; lines 35 to 41 discuss the preference of cerium oxide for such purpose:

To produce better conversion of oxidizable hazardous components under these conditions, oxygen-storing components such as, for example, pure cerium oxide or cerium oxide-containing components are used which bind oxygen when it is present in excess and release it again when there is a deficiency of oxygen in the exhaust gas.

Indeed, Lindner has no disclosure of the use of a NOx adsorption component in the exhaust gas catalyst.

Lindner discloses an exhaust gas catalyst containing two catalytically active layers on a carrier structure as depicted in the diagram below:

<u>2<sup>nd</sup> layer</u> <ol style="list-style-type: none"><li>1. several finely divided solids wherein at least one is finely divided oxygen-storage material, and</li><li>2. at least one platinum group metal; only a portion of these finely divided solids in the second layer is used as support for the platinum group metals in the second layer.</li></ol>
<u>1<sup>st</sup> layer</u> <ol style="list-style-type: none"><li>1. several finely divided solids wherein at least one is finely divided oxygen-storage material,</li><li>2. one or more highly dispersed alkaline earth metal oxides and</li><li>3. at least one platinum group metal. The platinum group metals are in close contact with all of the constituents in the first layer.</li></ol>
Carrier Structure

The first layer applied to the carrier structure is described in col. 4, lines 26 to 34. See the diagram above. The second layer is described in col. 4, lines 48 to 60; see the diagram above.

The finely divided solids in each of these layers comprise at least one finely-divided oxygen-storing material and at least one other finely divided component.

Serial No. 09/735,930

The "finely divided components" are described in Linder at col. 4, line 61 to col. 5, line 10. The "finely divided components" may be oxides of alkaline earth metal, oxides of scandium, yttrium, gallium, indium, silicon, titanium, zirconium, hafnium, germanium, tin, lead, vanadium, niobium, tantalum, chromium, molybdenum, and tungsten.

The Lindner catalyst is not a NO<sub>x</sub> adsorption catalyst. See the description of the purpose of the catalyst in col. 4, lines 10-22:

To reduce cold-start emissions, start catalysts and main catalysts are installed near the engine, these being heated to their light-off temperatures very rapidly by the hot exhaust gases, but also being subjected to peak temperatures of up to 1050°C. at the entrance to the catalyst during the normal driving phase. An object of the present invention is, therefore, to provide a catalyst which has a higher activity and heat resistance than known catalysts. A further object of the invention is to achieve a higher activity and heat resistant catalyst with the smallest possible amount of noble metals, that is in the most cost-effective manner possible.

There is no mention of forming an improved NO<sub>x</sub> adsorption catalyst.

Claims were changed in the Amendment filed November 1, 2002, to specify that the catalyst layer contains an alkali metal by deleting the phrase "and/or alkaline earth metal." See

Serial No. 09/735,930

page 2, line 6 et seq. of the specification where Li, Na and K are noted especially to cause corrosion and deterioration. There is no mention of having an alkali metal present in the Linder catalyst. The Examiner so acknowledges; see the first full paragraph on page 3 of the Final Rejection.

Deeba relates to a multi-zoned catalytic trap for converting NO<sub>x</sub> in an exhaust gas stream leaving an engine that is operated with periodic alternations between lean and stoichiometric (or rich) conditions. See col. 5, lines 3 to 6, where the first embodiment is discussed:

The first embodiment of the invention pertains to a multi-zoned catalytic trap having a first zone, a second zone and optionally, one or more zones intermediate the first and second zones.

See col. 8, lines 58 to 63, where the second embodiment is discussed:

As a second embodiment of the invention, the first catalytic trap material, second catalytic trap material and optional intermediate catalytic trap materials in the first, second and optional intermediate zones, respectively, are present as a discrete bottom layer and a discrete top layer overlying the bottom layer.

See col. 10, lines 31 to 60, for a discussion of the third embodiment; the summary at lines 31 to 36 reads:

As a third embodiment, the catalytic trap of the invention may be prepared in the form of layers, but without any zones within either the bottom or the top layer. In this third embodiment, the catalytic trap will nevertheless be "multi-zoned" because of post-impregnated layers superimposed on "zones," i.e., "sections," of the top layer.

The Examiner contends that Deeba teaches a similar exhaust gas catalyst utilizing one or more alkali metals as a NO<sub>x</sub> sorbent and cites Deeba at col. 23, lines 28 to 31. That cited passage is of a part of claim 1 where the first catalytic trap material in part (B) is said to comprise:

(B) a NO<sub>x</sub> sorbent comprising one or more basic oxygenated compounds of one or more alkaline earth metals and optionally, one or more basic oxygenated compounds of one or more alkali metals. (Emphasis added)

This broad NO<sub>x</sub> sorbent language is found throughout Deeba. The use of alkali metals clearly is optional.

In the Deeba examples (Example 1 Traps A-F and Example 5 Trap G), the NO<sub>x</sub> sorbent has the following approximate composition:

0.115 g/in<sup>3</sup> BaO;  
0.50 g/in<sup>3</sup> CeO<sub>2</sub>BZrO<sub>2</sub>;  
0.08 g/in<sup>3</sup> ZrO<sub>2</sub>



Serial No. 09/735,930

with only compounds of the alkaline earth metal barium (Ba) being used.

However, the production of Trap A is described in col. 18, lines 41 to 43, thusly:

After the one-zoned catalytic trap was prepared, it was post-dipped with Cs to provide a  $\text{Cs}_2\text{O}$  post-dipped coat of  $0.35 \text{ g/in}^3$ .

This applied alkali metal cesium (Cs) is the least reactive of the alkali metals.

A post-dipping procedure is described in col. 21, lines 24-31:

#### 7. Post-dipping

The calcined catalyst was then post-dipped in a solution of cesium nitrate and/or barium nitrate,  $\text{NO}_x$  sorbent precursor compounds, in an amount to provide in the finished catalytic trap the weights of cesium oxide and/or barium oxide indicated in Example 1. The post-dipped trap members were then dried at  $110^\circ\text{C}$ . for 4 hours and calcined at  $550^\circ\text{C}$ . for 1 hour.

There is no mention of using any of the active alkali metals discussed on the top of page 2, lines 2 to 10, of the present specification where these alkali metals Li, Na, and K and the active alkaline earth Ca are listed.

The references provide no motivation to an artisan to combine the teachings of Lindner and Deeba to solve the problem

Serial No. 09/735,930

of the deterioration of the substrate by the alkali metal used as NO<sub>x</sub> adsorption component.

Both of the references say nothing about an alkali metal-caused deterioration problem of a substrate such as cordierite. For example, Deeba in col. 2, lines 56 to 62, informs us:

Although lean-burn engines provide enhanced fuel economy, they have the disadvantage that conventional TWC catalysts are not effective for reducing NO<sub>x</sub> emissions from such engines because of excessive oxygen in the exhaust.

There is no mention of any substrate deterioration problem; one is informed merely that TWC catalysts do not effectively reduce NO<sub>x</sub>. Lindner, on the other hand, suggests merely an alternate use of a metal substrate and a ceramic substrate. See col. 1, lines 42 to 51:

The present invention deals with catalyst coatings on inert, monolithic carrier structures, in particular honeycomb structures with parallel flow channels for the exhaust gas. The number of flow channels per cross-sectional area is called the cell density. Inert carrier structures with cell densities between 10 and 250 cm<sup>2</sup> are used, depending on the requirements of the application. These may be extruded, ceramic carrier structures made from cordierite, mullite or similar, temperature resistant materials. Alternatively, honeycomb structures made from steel sheeting may be used.

Serial No. 09/735,930

The Significance of These Two References Being Directed to Different Types Of Automotive Catalysts

a) Linder - Passive Catalyst System - Operating at Stoichiometric Point

The Linder catalyst is a three-way catalyst system used for normal engines where exhaust gas is controlled to the stoichiometric point. This catalyst system is a "passive" catalyst system, that is, it converts CO, HC, and NOx to harmless components at the same time and constantly in a stoichiometric atmosphere.

This catalyst is composed generally of:

- 1) a noble metal,
- 2) a support (heat resistant inorganic oxide such as  $\gamma$ - $\text{Al}_2\text{O}_3$ ),

and

- 3) an oxygen storage material (such as  $\text{CeO}_2$  to keep the exhaust gas composition stoichiometric).

a) Deeba - Active Catalyst System - Operating in a Lean Atmosphere

The Deeba catalyst is for an NOx adsorption catalyst system that is used for a lean burn engine or a direct injection engine

Serial No. 09/735,930

where the exhaust gas is in a lean atmosphere, that is, there is excess  $O_2$  in the atmosphere. This catalyst system is an "active" catalyst system, that is, it adsorbs  $NO_x$  during lean operation. Then introducing a rich spike at intervals discharges the adsorbed  $NO_x$ , and the discharged  $NO_x$  is converted to harmless components, so that saturation of  $NO_x$  in the adsorption material is avoided.

This catalyst is generally composed of:

- 1) a noble metal,
- 2) a support (heat resistant inorganic oxide such as  $\gamma$ - $Al_2O_3$ ), and
- 3) an  $NO_x$  adsorption material (such as Ba, K to hold  $NO_x$  in the form of nitrate).

As noted, the treating gas and the reaction mechanisms of Linder and Deeba catalyst systems are totally different. Thus, a skilled person would not think that an effective component for one catalyst system is effective for another catalyst system acting by a different reaction mechanism. This belief is a common sense one in chemistry. Therefore, without any suggestion

Serial No. 09/735,930

or teaching to do so, the skilled person could not combine the Linder and Deebea teachings.

In other words, because these two references relate to different types of automotive catalysts, no suggestion is provided by or in the references to combine their features. As already noted, the recited objects for the Lindner catalyst establish it is merely an ordinary automotive catalyst with noble metals to provide for high temperature resistance. Deebea, on the other hand, is directed to a NO<sub>x</sub> conversion catalyst having primarily an alkaline earth (Ba) component. There is no suggestion to the person of ordinary skill in the catalyst art to take a Deebea NO<sub>x</sub> catalyst component and randomly add it to a conventional noble metal-containing auto exhaust catalyst. There is no reason, other than by the improper resort to hindsight, to do so. There clearly is no teaching in these two references of the unexpected and superior results obtained by applicants and compiled in Tables 1 and 2 of the specification.

Applicants believe that one of the first recognitions of the ceramic substrate deterioration problem is found in JP-A-10-165817, having a relatively recent publication date of June 23, 1998. A copy with an English abstract is submitted herewith.

Serial No. 09/735,930

The abstract contains a statement that improved durability against high temperature for a NO<sub>x</sub> inclusion material containing an alkali metal can be achieved by using a support that has no silicon (Si); alpha-alumina and zirconia are preferred. Lindner and Deeba do not relate to recognizing and solving the problem recognized and discussed in JP-A-10-165817.

Accordingly, reconsideration and withdrawal of the rejection is earnestly solicited.

4. EP 657,204

The Examiner discussed EP 657,204 during the May 13, 2003 interview. The Interview Summary contains a statement:

It also appears to the examiner that the newly submitted European Patent (EP 057 204 A1) reads on at least claim 1 because it discloses the claimed catalyst with a carrier including the claimed substance and a NO<sub>x</sub> adsorbent containing alkali metals.

Applicants respectfully but strongly disagree.

EP-A-657,204 discloses using TiO<sub>2</sub>-Al<sub>2</sub>O<sub>3</sub> instead of γ-Al<sub>2</sub>O<sub>3</sub> as a support material for pre-doping noble metal and NO<sub>x</sub> adsorption material thereon. In the catalyst body of the instant claims, the support material is described as a "heat resistant inorganic oxide" used in addition to the anchor

Serial No. 09/735,930

substance in the present invention. In this respect, see specification Paragraphs [0015] to [0020]. See particularly Paragraph [0016], where it is stated that "in NO<sub>x</sub> adsorption catalysts, a catalyst component is loaded on a carrier in a highly dispersed state; therefore, a heat-resistant inorganic oxide having a large specific surface area, such as  $\gamma$ -Al<sub>2</sub>O<sub>3</sub> or the like is used as a loading component of the catalyst layer."

Furthermore, the support material ( $\gamma$ -Al<sub>2</sub>O<sub>3</sub>) used for predoping a noble metal and an NO<sub>x</sub> adsorption material, is a material different from the anchor substance in all examples of the present specification. Therefore, the TiO<sub>2</sub>-Al<sub>2</sub>O<sub>3</sub> in EP-A-657 204 is not being used or is present as an anchor substance, but only as the heat-resistant inorganic oxide of the present invention. The anchor substance and the heat-resistant inorganic oxide are totally different.

Claim 1 has been amended to recite a heat-resistant inorganic oxide and a noble metal loaded on the heat-resistant inorganic oxide more clearly to distinguish patentably the catalyst body from the article of EP-A-657 204. Applicants submit that the TiO<sub>2</sub>-Al<sub>2</sub>O<sub>3</sub> disclosed in EP-A-657 204 differs from applicants' anchor substance and the publication clearly does

Serial No. 09/735,930

not disclose both the anchor substance and the heat-resistant inorganic oxide recited in amended claim 1. Accordingly, reconsideration of any proposed rejection based on EP-A-657 204.

Applicants respectfully submit that the present application is now in condition for allowance. Accordingly, the Examiner is requested to issue a Notice of Allowance for all pending claims.

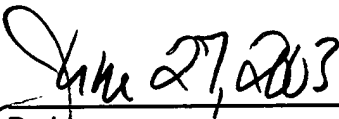
Should the Examiner deem that any further action by the applicants would be desirable for placing this application in even better condition for issue, she is asked to telephone the undersigned at the number listed below.

Respectfully submitted,

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